CLAIMS

What is claimed is

1. In a computing environment, an automated turbine component thermal response analysis method, comprising:

selecting a region of interest;

determining for the selected region of interest whether one or more thermal response metrics are within one or more corresponding acceptance ranges; and

if there is more than one region of interest, repeating said selecting of region of interest and said determining for the selected region of interest for each region of interest.

2. The method of claim 1, wherein said determining for the selected regions of interest whether thermal response metrics are within corresponding acceptance ranges comprises

determining a temperature threshold at which a sub-region within the selected region of interest has an area size equal to or greater than a critical area size, the sub-region having locations with temperatures equal to or greater than the temperature threshold; and

determining whether the determined temperature threshold is within a temperature threshold acceptance range.

3. The method of claim 2, wherein

said method further comprises selecting a frame of a thermal image comprising a plurality of pixels having pixel values corresponding to temperature; and

said determining of a temperature threshold comprises setting a working pixel value to a predetermined pixel value, and determining whether the number of pixels having pixel values greater than the working pixel value substantially equate to the critical area size.

4. The method of claim 3, wherein said determining of a temperature threshold further comprises

adjusting the working pixel value to a next pixel value to cause the number of pixels having pixel values greater than the working pixel value to equate closer to the critical area size, if the number of pixels having pixel values greater than the working pixel value do not substantially equate the critical area size; and

repeating said determining of whether the number of pixels having pixel values greater than the working pixel value substantially equate to the critical area size.

5. The method of claim 4, wherein said determining of a temperature threshold further comprises deriving the temperature threshold in accordance with the working pixel value that yielded a quantity of pixels with pixel values greater than the working pixel value, substantially equate to the critical area size.

6. The method of claim 3, wherein said selecting of a frame of a thermal image comprises selecting a peak frame from a plurality of frames.

7. The method of claim 2, wherein the selected region of interest is a primary region of interest.

8. The method of claim 2, wherein the selected region of interest is a region located in a selected one of a pressure side and leading edge, a pressure side and trailing edge, a suction side and leading edge, a suction side and trailing edge, and a leading edge of the turbine component.

9. The method of claim 1, wherein said determining for the selected region of interest whether thermal response metrics are within corresponding acceptance ranges comprises determining a sub-region within the selected region of interest, the sub-region having locations with temperatures greater than or equal to a temperature threshold.

10. The method of claim 9, wherein the temperature threshold is a determined temperature at which a sub-region within a primary region of interest reaches a critical area size.

11. The method of claim 9, wherein said determining for the selected region of interest whether thermal response metrics are within corresponding acceptance ranges further comprises determining whether the sub-region's area size is within a corresponding area size acceptance range.

12. The method of claim 9, wherein said determining for the selected region of interest whether thermal response metrics are within corresponding acceptance ranges further comprises determining whether a ratio of the sub-region's area size to a reference sub-region's area size is within a corresponding area size ratio acceptance range.

13. The method of claim 12, wherein the selected region of interest is a secondary region of interest, and the reference sub-region is a sub-region within a primary region of interest.

14. The method of claim 9, wherein the selected region of interest is a secondary region of interest.

15. The method of claim 9, wherein the selected region of interest is a region located in a selected one of a pressure side and leading edge, pressure side and trailing edge, suction side and leading edge, suction side and trailing edge, and leading edge of the turbine component.

16. The method of claim 1 wherein said determining for the selected region of interest whether thermal response metrics are within corresponding acceptance ranges comprises determining whether a sub-region within the selected region of interest has a shape that substantially equates to a critical shape.

17. The method of claim 16, wherein

said method further comprises selecting a frame of a thermal image comprising a plurality of pixels; and

said determining of whether the sub-region's shape substantially equates to a critical shape comprises performing one or more weighted moment analyses based on constituting pixels of the sub-region.

18. The method of claim 17, wherein each of the one or more weighted moment analyses comprises determining a weighted moment value, and determining whether the weighted moment value is within a corresponding moment value acceptance range.

19. The method of claim 18, wherein the weighted moment value is a weighted moment value of a selected combination of moment orders of a first and a second direction.

20. The method of claim 19, wherein the weighted moment orders are selected from a group comprising a zero order moment, a first order moment, a second order moment, and a third order moment..

21. The method of claim 18, wherein the weighted moment value is a selected one of a centroid compensated weighted moment value, a normalized weighted moment value and an invariant weighted moment value.

22. The method of claim 16, wherein said selecting of a frame of a thermal image comprises selecting a peak frame from a plurality of frames.

23. The method of claim 16, wherein said determining for the selected region of interest whether thermal response metrics are within corresponding acceptance ranges further comprises determining whether the sub-region's shape corresponds to a reference sub-region's shape in an expected way.

24. The method of claim 23, wherein the selected region of interest is a secondary region of interest, and the reference sub-region is a sub-region within a primary region of interest.

25. The method of claim 1, wherein the method further comprises deciding based at least in part on the results of said determining, whether the turbine component should be considered as having passed or failed the inspection.

26. In a computing environment, an automated turbine component thermal response analysis method, comprising:

setting a working pixel value to a predetermined pixel value;

determining whether the number of pixels within a region of a frame having pixel values greater than the working pixel value substantially equate to a critical area size, the frame pictorially capturing thermal response of a turbine component to thermal stimuli applied to the turbine component,

adjusting the working pixel value to a next pixel value to cause the number of pixels within the region having pixel values greater than the working pixel value to equate closer to the critical area size, if the number of pixels within the region having pixel values greater than the working pixel value do not substantially equate the critical area size; and

repeating said determining of whether the number of pixels within the region having pixel values greater than the working pixel value substantially equate to the critical area size, and said adjusting, until the number of pixels within the region having pixel values greater than the working pixel value substantially equate to the critical area size.

27. The method of claim 26, wherein said method further comprises deriving a temperature threshold in accordance with the working pixel value that yielded a quantity of pixels within the region with pixel values greater than the working pixel value, substantially equate to the critical area size.

28. The method of claim 26 wherein the method further comprises performing one or more weighted moment analyses based on the pixels within the region with pixel values greater than the terminating working pixel value.

29. The method of claim 28, wherein each of the one or more weighted moment analyses comprises determining a weighted moment value, and determining whether the weighted moment value is within a corresponding moment value acceptance range for the moment order.

30. The method of claim 29, wherein the weighted moment value is a weighted moment value of a selected combination of moment orders of a first and a second direction.

31. The method of claim 30, wherein the weighted moment orders are selected from a group comprising a zero order moment, a first order moment, a second order moment, and a third order moment.

32. The method of claim 29, wherein the weighted moment value is a selected one of a centroid compensated weighted moment value, a normalized weighted moment value and an invariant weighted moment value.

33. In a computing environment, an automated turbine component thermal response analysis method, comprising:

processing a subset of pixels within a region of a frame pictorially capturing thermal response of a turbine component to thermal stimuli applied to the turbine component to compute a weighted moment value of a first moment order in a first direction and a second moment order in a second direction; and

determining based at least in part on said weighted moment value, whether the subset of pixels substantially equate to a critical shape.

34. The method of claim 33, wherein said moment orders are selected from a group comprising a zero moment order, a first moment order, a second moment order, and a third moment order.

35. The method of claim 33, wherein

said processing of the subset of pixels within the region is performed a plurality of times to compute a plurality of said weight moment values;

the method further comprises computing one or more derivative moment values based on said plurality of weighted moment values; and

said determining is further based on said one or more derivative moment values.

36. The method of claim 35, wherein said one or more derivative moment values comprises one or more of a centroid compensated moment value, a normalized moment value, and an invariant moment value.

37. An apparatus comprising:

at least one storage unit having stored therein programming instructions designed to enable the apparatus to

select a region of a thermal image of a turbine component's thermal response to application of thermal stimuli to the turbine component, corresponding to a region of interest,

determine for the region of interest, using the selected corresponding region of the thermal image, whether one or more thermal response metrics are within one or more corresponding acceptance ranges, and

repeat said selection of a corresponding region of a thermal image, and said determination for the region of interest, for each region of interest if there is more than one region of interest; and

at least one processor coupled to the at least one storage unit to execute the programming instructions.

38. The apparatus of claim 37, wherein said programming instructions enable said apparatus to perform said determining by

determining a temperature threshold at which a sub-region within the region of interest has an area size equal to or greater than a critical area size, the sub-region having locations with temperatures equal to or greater than the temperature threshold, and

determining whether the determined temperature threshold is within a temperature threshold acceptance range.

39. The apparatus of claim 38, wherein the programming instructions further enable the apparatus to

select a frame of a thermal image comprising a plurality of pixels having pixel values corresponding to temperature as said thermal image, and

perform said determining by setting a working pixel value to a predetermined pixel value, and determine whether the number of pixels having pixel values greater than the working pixel value substantially equate to the critical area size.

40. The apparatus of claim 39, wherein said programming instructions enable said apparatus to perform said determining by

adjusting the working pixel value to a next pixel value to cause the number of pixels having pixel values greater than the working pixel value to equate closer

to the critical area size, if the number of pixels having pixel values greater than the working pixel value do not substantially equate the critical area size; and

repeating said determining of whether the number of pixels having pixel values greater than the working pixel value substantially equate to the critical area size.

41. The apparatus of claim 40, wherein said programming instructions enable the apparatus to perform said determining by additionally deriving the temperature threshold in accordance with the working pixel value that yielded a quantity of pixels with pixel values greater than the working pixel value, substantially equate to the critical area size.

42. The apparatus of claim 49, wherein said programming instructions enable the apparatus to perform said selecting of a frame of a thermal image by selecting a peak frame from a plurality of frames.

43. The apparatus of claim 37, wherein the region of interest is a primary region of interest.

44. The apparatus of claim 37, wherein the region of interest is a region located in a selected one of a pressure side and leading edge, a pressure side and trailing edge, a suction side and leading edge, a suction side and trailing edge, and a leading edge of the turbine component.

45. The apparatus of claim 37, wherein said programming instructions enable the apparatus to perform said determining by determining a sub-region within the region of interest, the sub-region having locations with temperatures greater than or equal to a temperature threshold.

46. The apparatus of claim 45, wherein the temperature threshold is a determined temperature at which a sub-region within a primary region of interest reaches a critical area size.

47. The apparatus of claim 45, wherein said programming instructions enable the apparatus to perform said determining by determining whether the sub-region's area size is within a corresponding area size acceptance range.

48. The apparatus of claim 45, wherein said programming instructions enable the apparatus to perform said determining by determining whether a ratio of the sub-region's area size to a reference sub-region's area size is within a corresponding area size ratio acceptance range.

49. The apparatus of claim 48, wherein the region of interest is a secondary region of interest, and the reference sub-region is a sub-region within a primary region of interest.

50. The apparatus of claim 45, wherein the region of interest is a secondary region of interest.

51. The apparatus of claim 45, wherein the region of interest is a region located in a selected one of a pressure side and leading edge, pressure side and trailing edge, suction side and leading edge, suction side and trailing edge, and leading edge of the turbine component.

52. The apparatus of claim 37, wherein said programming instructions enable the apparatus to perform said determining by determining whether a sub-region within the selected region of interest has a shape substantially that equates to a critical shape.

53. The apparatus of claim 52, wherein said programming instructions further enable the apparatus to

select a frame of a thermal image comprising a plurality of pixels as the thermal image, and

perform said determining by performing one or more weighted moment analyses based on constituting pixels of the sub-region.

54. The apparatus of claim 53, wherein said programming instructions enable the apparatus to perform each of the one or more weighted moment analyses by

determining a weighted moment value, and determining whether the weighted moment value is within a corresponding moment value acceptance range.

55. The apparatus of claim 54, wherein the weighted moment value is a weighted moment value of a selected combination of moment orders of a first and a second direction.

56. The apparatus of claim 55, wherein the weighted moment orders are selected from a group comprising a zero order moment, a first order moment, a second order moment, and a third order moment.

57. The apparatus claim 55, wherein the weighted moment value is a selected one of a centroid compensated weighted moment value, a normalized weighted moment value and an invariant weighted moment value.

58. The apparatus of claim 52, wherein said programming instructions enable the apparatus to select a peak frame from a plurality of frames as the thermal image.

59. The apparatus of claim 52, wherein said programming instructions enable the apparatus to perform said determining by determining whether the sub-region's shape corresponds to a reference sub-region's shape in an expected way.

60. The apparatus of claim 59, wherein the region of interest is a secondary region of interest, and the reference sub-region is a sub-region within a primary region of interest.

61. The apparatus of claim 37, wherein said programming instructions further enable the apparatus to decide based at least in part on the results of said determining, whether the turbine component should be considered as having passed or failed the inspection.

62. An apparatus comprising:

at least one storage unit having stored therein a plurality of programming instructions designed to enable the apparatus to

set a working pixel value to a predetermined pixel value,

determine whether the number of pixels within a region of a frame having pixel values greater than the working pixel value substantially equate to a critical area size, the frame pictorially capturing thermal response of a turbine component to thermal stimuli applied to the turbine component,

adjust the working pixel value to a next pixel value to cause the number of pixels within the region having pixel values greater than the working pixel value to equate closer to the critical area size, if the number of pixels within the region having pixel values greater

than the working pixel value do not substantially equate to the critical area size, and

repeat said determining of whether the number of pixels within the region having pixel values greater than the working pixel value substantially equate to the critical area size, and said adjusting, until the number of pixels within the region having pixel values greater than the working pixel value substantially equate to the critical area size; and

at least one processor coupled to said at least one storage unit to execute said programming instructions.

63. The apparatus of claim 62, wherein said programming instructions further enable the apparatus to derive a temperature threshold in accordance with the working pixel value that yielded a quantity of pixels within the region with pixel values greater than the working pixel value, substantially equate to the critical area size.

64. The apparatus of claim 62, wherein said programming instructions further enable the apparatus to perform one or more weighted moment analyses based on the pixels within the region with pixel values greater than the terminating working pixel value.

65. The apparatus of claim 64, wherein said programming instructions enable the apparatus to perform each of the one or more weighted moment analyses by determining a weighted moment value, and determining whether the weighted moment value is within a corresponding moment value acceptance range.

66. The apparatus of claim 65, wherein the weighted moment value is a weighted moment value of a selected combination of moment orders of a first and a second direction.

67. The apparatus of claim 66, wherein the weighted moment orders are selected from a group comprising a zero order moment, a first order moment, a second order moment, and a third order moment..

68. The apparatus of claim 65, wherein the weighted moment value is a selected one of a centroid compensated weighted moment value, a normalized weighted moment value and an invariant weighted moment value.

69. An apparatus comprising:

at least one storage unit having stored therein a plurality of programming instructions designed to

process a subset of pixels within a region of a frame pictorially

capturing thermal response of a turbine component to thermal

stimuli applied to the turbine component to compute a weighted

moment value of a first moment order in a first direction and a second moment order in a second direction; and

determine based at least in part on said weighted moment value, whether the subset of pixels substantially equate to a critical shape.

70. The apparatus of claim 69, wherein said moment orders are selected from a group comprising a zero moment order, a first moment order, a second moment order, and a third moment order.

71. The apparatus of claim 69, wherein said programming instructions enable the apparatus to

perform said processing of the subset of pixels within the region a number of times to compute a plurality of weighted moment values;

compute one or more derivative moment values based on said computed weighted moment values; and

further basing said determination on said one or more derivative moment values.

72. The apparatus of claim 61, wherein said one or more derivative moment values are one or more of a centroid compensated moment value, a normalized moment value, and an invariant moment value.